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# APPARATUS AND METHOD FOR FABRICATING LIQUID CRYSTAL DISPLAY DEVICE

[Abstract]

PROBLEM TO BE SOLVED: To provide an apparatus and a method for manufacturing a liquid crystal display element which can use a mask even in a vacuum atmosphere, and does not cause damage to the substrate.

SOLUTION: The mask 5 is fixed by screwing on a lower surface plate 1a, and an adhesive member 5b is embedded in a recess 5a provided at a portion corresponding to the liquid crystal display area of a lower substrate 2a. The lower substrate 2a is adhered to and fixed on the mask 5 by using the adhesive member 5b. In the state where the power source of the electrostatic zipper 8 provided on the upper surface plate 1b is turned ON, and the electrostatic suction fixing of the upper substrate 2b is performed on the upper surface plate 1b, the lower surface

plate 1a is displaced upward by a Z-axis driving source 10 until it comes into contact with an O ring 9 provided on the upper substrate 2b. After making the circumferential atmosphere of the substrates surrounded by both surface plates 1a and 1b and the O ring 9 into a vacuum atmosphere, the position adjustment of both substrates 2a and 2b is performed by an XY θ -axis driving source 11, the lower surface plate 1a is displaced upward to stick both substrates 2a and 2b.

[Claims]

1. An apparatus for fabricating a liquid crystal display device in which a pair of substrates are laminated and bonded on a pair of base plates facing each other, the apparatus provided with a rigid mask having recessed parts in portions corresponding to liquid crystal display regions of the substrate, and an adhesive member positioned in each recessed part having adherence and ductility and thus supporting the substrate by its viscosity.

2. The apparatus of claim 1, comprising: a unit for making the surroundings of the substrates be in a vacuum state, and a coating unit for coating a liquid crystal onto one substrate supported by the base plate.

3. The apparatus of claim 1 or 2, wherein when the pair of base plates is bonded with positioning both the substrates therebetween, a load matched with a force for bonding the substrates is applied from a rear side of the adhesive member.

4. The apparatus of any of claims 1 to 3, wherein the load applied from the rear side is generated by using pressurized air.

5. A method for fabricating a liquid crystal display device which is fabricated by laminating a pair of substrates to bond both the substrates on a pair of base plates facing with each other, the method comprising: forming rigid recessed parts at portions corresponding to liquid crystal display regions of the substrates; installing a mask having the recessed parts therein, in each of which

an adhesive member having adherence and ductility is filled, at one base plate to adhere the display regions of one substrate onto the adhesive member; supporting a surrounding portion of the one substrate on the mask and maintaining a supported state on the one base plate ; and supporting the other substrate on the other base plate to bond both the substrates.

[Title of the Invention]

APPARATUS AND METHOD FOR FABRICATING LIQUID CRYSTAL DISPLAY DEVICE

[Detailed Description of the Invention]

[Field of the Invention]

The present invention relates to an apparatus for fabricating a liquid crystal display device and method therefor in which a pair of substrates are laminated and bonded with each other on a pair of base plates facing each other to fabricate the liquid crystal display device.

[Description of the Prior Art]

A liquid crystal display device is fabricated by laminating a pair of substrates having a display electrode or an alignment layer and sealing a liquid crystal between the substrates. In the bonding process for the substrates, the substrates are supported on a pair of base plates to be aligned and bonded therewith in a longitudinal direction and bonded with the base plate. The substrates are then pressurized downwardly until a predetermined gap is formed, and a prefixed sealant is hardened. After being bonded, the substrates are pressed and sealed down to a cell-gap according to product models.

Figure 5 shows a construction of a prior art apparatus for fabricating a liquid crystal display device. Substrates 2a and 2b are absorbed and supported onto a pair of base plates 1a and 1b in vacuum. The substrates 2a and 2b are aligned and bonded with each other in a longitudinal direction using a XYθ axis driving source 10 and a Z-axis driving source 11 and a load is applied thereto.

Both the substrates 2a and 2b are thusly bonded. At this time, as shown in Figure 6, when a fine impurity 3 such as cullet exists on the lower base plate 1a, a protrusion 4 may be formed in the lower substrate 2a due to the impurity 3. When the alignment is carried out in the longitudinal direction in the state that the protrusion 4 is formed, the bonded surface may be damaged.

On the contrary, Figure 7 shows a method and apparatus for bonding substrates with each other and a fabrication method for a liquid crystal display device. In these apparatus and method, a mask 6 with recessed parts therein 5a is loaded on the lower base plate 1a and the lower substrate 1a is loaded on the mask 5, thereby bonding both the substrates 2a and 2b. Because a surface of the lower substrate 2a facing the mask 5 is not contact with the mask 5 by the recessed parts 5a formed in the mask 5, even if impurity exists between the mask 5 and the substrate 2a at the area where the recessed part 5a face the substrate 2a, the impurity is positioned in the recessed part 5a. As a result, the substrates can be prevented from being damaged while bonding with each other. The mask 5 is fixed to the lower base plate 1a by an absorption in vacuum. The lower substrate 2a is absorbed and fixed onto the mask 5 in vacuum through a protrusion hole formed in the mask 5. Therefore, when the size of the substrate, the shape of the liquid crystal display region, and the like are changed, it is convenient to correspond to the change by replacing the mask 5.

In addition, in the method for fabricating a liquid crystal display panel disclosed in Japanese Laid Open No. 59-17533, a liquid crystal display panel arranged on a first support member in a vacuum tube is bonded with a thin film supported by a second support member, positioning an elastic body and an adhesive member under the elastic body between the thin film and the second

support member, and accordingly the pressure generated in bonding can prevent the thin film from being scratched or fractured.

[Problems to be Solved by the Invention]

In the process for fabricating the liquid crystal display device in the prior art, such processes of a substrate division, liquid crystal injection, and sealing are required for the process for bonding substrates with each other, however, a fabrication method so-called a bonding injection method (or dropping injection method) integrating all of these processes therein is proposed.

Figure 8 shows an apparatus for fabricating a liquid crystal display device according to the bonding injection method. In this apparatus, a pair of substrates 2a and 2b are supported on a pair of base plates 1a and 1b. One substrate 2a is coated with a certain amount of liquid crystal 6, and the other substrate 2b is coated with a sealant. Spacers (not shown) are spread over the other substrate 2b. An operation for making a space be in vacuum using a vacuum pump 12 is carried out to form a vacuum chamber 7. The two substrates 2a and 2b are aligned in a longitudinal direction using a XYθ-axis driving source 10 and a Z-axis driving source 11. The two substrates 2a and 2b are bonded by applying a predetermined load and pressed down to a cell-gap according to product models.

Thus, if the bonding injection method is applied to the fabrication apparatus shown in Figure 7 in order to perform the bonding in a vacuum state, the mask 5 and the substrates 2a and 2b can not be absorbed and fixed to each other in the vacuum state, and accordingly the two substrates 2a and 2b can not be aligned in the longitudinal direction.

In the bonding injection method, the substrates should be pressed down to

a cell-gap of a product model within the same process, so as to press the substrates by applying a load larger than the prior art load. At this time, the substrates may be deformed by the recessed parts 5a formed in the mask 5, and a uniform cell-gap can not be obtained.

An object of the present invention is to provide an apparatus and method for fabricating a liquid crystal display device capable of using a mask even in a vacuum condition and preventing the substrates from being damaged.

[Means for Solving the Problem]

To achieve the above object of the present invention, there is provided an apparatus for fabricating a liquid crystal display device which is fabricated by laminating and bonding a pair of substrates on a pair of base plates, the apparatus including a rigid mask having recessed parts in portions corresponding to liquid crystal display regions of the substrate, and an adhesive member positioned in each recessed part having adherence and ductility and thus supporting the substrate by its viscosity.

In accordance with the present invention, since each recessed part of the mask has the adhesive member having adherence and ductility and supporting the substrates by its viscosity, the substrate can adherently be fixed and a misalignment in a longitudinal direction can be prevented as well as preventing the substrate from being damaged due to impurity between the substrate and the base plate.

The apparatus for fabricating a liquid crystal display device includes a unit for making the circumference of the substrate be in a vacuum state, and a coating unit for coating a liquid crystal onto one substrate supported by the base plate.

In accordance with the present invention, since the apparatus for fabricating a liquid crystal display device includes the unit for making the circumference of the substrate be in a vacuum state and a coating unit for coating a liquid crystal onto one substrate supported by the base plate, the substrate can be prevented from being damaged.

The present invention is also characterized by which when both substrates are bonded with each other between a pair of base plates, a load matched with a force required for the bonding is applied from the rear side of the adhesive member.

In accordance with the present invention, since the load matched with the force required for bonding the substrates is applied from the rear side of the adhesive member, the substrates can be prevented from being deformed when they are bonded. In addition, the load applied from the rear side is generated by using pressurized air.

According to the present invention, the load is generated by using the pressurized air, the load is uniformly applied to the rear side of the adhesive member and the substrates can be prevented from being deformed.

According to another object of the present invention, a method for fabricating a liquid crystal display device which is fabricated by laminating a pair of substrates to bond both the substrates on a pair of base plates facing each other, the method including: forming rigid recessed parts in portions corresponding to liquid crystal display regions of the substrates; installing a mask having the recessed parts therein, in each of which an adhesive member having adherence and ductility is filled, at one base plate to adhere the display regions of the one substrate onto the adhesive member; supporting a circumferential portion of the

one substrate on the mask and maintaining the supported state on the one base plate ; and supporting the other substrate on the other base plate to bond both the substrates.

According to the present invention, the mask can be used even in a vacuum condition and a liquid crystal display device without any damage on the substrates can be fabricated.

[Embodiment of the Invention]

Fig. 1 shows a construction of an apparatus (hereinafter, referred to as a fabricating apparatus) for fabricating a liquid crystal display device according to an embodiment of the present invention. The fabricating apparatus includes a pair of base plates 1a and 1b, a mask 5 having a rigid recessed part 5a, an adhesive member 5b with ductility buried in the recessed part 5a, an electrostatic chuck 8, O-ring 9, and a XYθ axis driving source 10 and Z-axis driving source 11.

The method for fabricating the liquid crystal display device using such constructed fabricating apparatus will now be explained. First, an upper substrate 2b is absorbed and fixed onto an upper base plate 1b in vacuum by using a vacuum aspirator such as a vacuum pump (now shown) under atmospheric pressure. A liquid crystal is coated onto the almost same region as the liquid crystal display region from a side surface of the upper substrate 2b facing a lower substrate 2a by a liquid crystal coating unit (now shown). The mask 5 is fixed onto a lower base plate 1a by a screw, and the adhesive member 5b is buried in each recessed part positioned at a place corresponding to the liquid crystal display region of the lower substrate 2a. The lower substrate 2a is adhered and fixed onto the mask 5 by the adhesive member 5b. A sealant is coated on and spacers are

spread over the side surface of the lower substrate 2b facing the upper substrate 2a.

Next, the lower substrate 1a is contact with the O-ring 9 provided on the lower base plate 1b. Accordingly, as shown in Fig. 2, the circumference of the substrates is sealed by being surrounded by both the base plates 1a and 1b and the O-ring both of which act as a sealing unit. The circumference of the substrates is in a vacuum state using the vacuum aspirator such as a vacuum pump (not shown). The upper base plate 1b is moved in all directions and rotated by the XYθ axis driving source 10 and both the substrates 2a and 2b are aligned. The lower base plate 1a is moved upwardly to bond both the substrates 2a and 2b. A load is further applied to the lower base plate 1a by the Z-axis driving source 10 to press the substrates up to a cell-gap according to a product model. This new load deforms a portion where the lower substrate 2a is contact with the recessed part 5a, which may cause damage on the lower substrate 2a. Therefore, as the load matched with the force for bonding the substrates 2a and 2b is applied from the rear side of the adhesive member 5b buried in each recessed part 5a, the load applied onto the substrates is offset. As a result, the lower substrate 2a can be protected from being deformed.

Fig. 3 is an enlarged view showing the recessed part 5a formed in the mask 5. The recessed part 5a can be divided into a portion facing the lower substrate 2a and a portion facing the lower base plate 1a in a sealed state by a thin plate 5c which is movable in upper and lower directions. A sealed space 5c surrounded by the thin plate 5c and a lower portion of the recessed part 5c is formed at a portion facing the lower base plate 1a. A vent stack 5f for introducing air from the exterior into the sealed space 5e is formed up to the sealed space 5e

from a surface being contact with the lower base plate 1. The adhesive member 5b is adhered onto the thin plate 5c at a position where the adhesive member 5b faces the lower substrate 2a, and a protrusion 5d is formed to prevent the thin plate 5c from being released out of the recessed part 5a.

When the Z-axis driving source 10 moves upwardly to bond substrates, a force matched with the force for bonding the substrates is applied with respect to the adhesive member 5b from the lower substrate 2a toward the lower base plate 1a. At this time, as shown in Fig. 4, pressurized air is sent to the sealed space 5e through the vent stack 5f by a compressor (now shown), and the pressurized air pushes the thin plate 5c upwardly to generate a load corresponding to the force for bonding the substrates from the rear side of the adhesive member 5b, which results in preventing the substrates from being deformed.

[Effect of the Invention]

As aforementioned, as the substrates are fixed by the adhesive member, the substrates can uniformly be aligned in a longitudinal direction and also be prevented from being damaged even if impurities exist between the substrate and the base plate.

In addition, the mask can be used even in the vacuum state, and thus the substrates can be prevented from being damaged.

Furthermore, since the load matched with the force for bonding the substrates is applied from the rear side of the adhesive member, the substrates can be prevented from being deformed while performing their bonding operation.

Further, the load is uniformly applied to the rear side of the adhesive member, and thus the substrates can be prevented from being deformed.

[Brief Description for the Drawing]

Fig. 1 illustrates a construction of an apparatus for fabricating a liquid crystal display device as an embodiment of the present invention.

Fig. 2 shows a circumference of the substrates where is sealed.

Fig. 3 is an enlarged view showing a recessed part 5a formed in a mask 5.

Fig. 4 shows a state that a load is applied onto an adhesive member 5b by pressurized air.

Fig. 5 shows a construction of a prior art apparatus for fabricating a liquid crystal display device.

Fig. 6 shows a state of a pair of base plates 1a and 1b and a pair of substrates 2a and 2b when impurities exist.

Fig. 7 shows a construction of an apparatus for fabricating a liquid crystal display device using a mask 5.

Fig. 8 shows an apparatus for fabricating a liquid crystal display device according to a bonding injection method.

[Explanation for Reference Symbol]

1a, 1b base plate, 2a, 2b substrate, 5 mask, 5a recessed part, adhesive member, 5c thin plate, 5d protrusion, 5e sealed space, 5f vent stack, 6 liquid crystal, 7 vacuum chamber, 8 electrostatic chuck, 9 O-ring, 10 XYθ axis driving source, 11 Z-axis driving source, 12 vacuum pump